Fluoroscopic Training and Dose Optimization Course for Fluoroscopy Users

<u>Minimize Dose to patient and prevent the possibility of acute radiation injuries</u>

The National Council on Radiation Protection and Measurements Report No. 160 — Ionizing Radiation Exposure of the Population of the United States indicated that <u>in 2006 Interventional Fluoroscopy was the third largest source of medical radiation exposure (14%) after computed tomography and nuclear medicine.</u> This represented an increase of > 450% from the 1980's.
https://ncrponline.org/wp-content/themes/ncrp/PDFs/Fig4-12.pdf

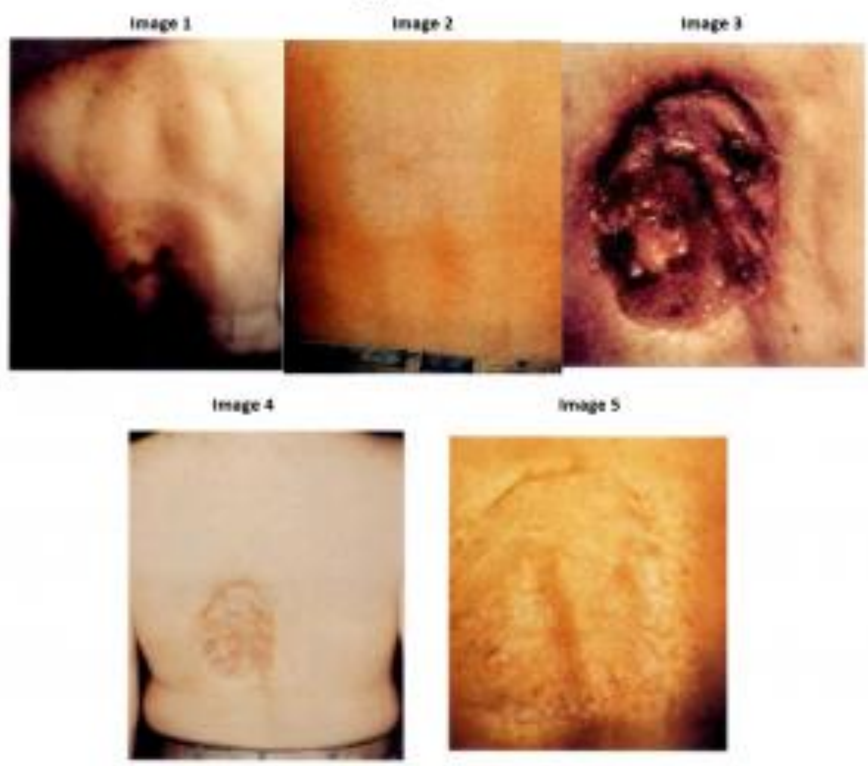
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<u>Deterministic Effects</u>

Severe skin injuries as a result of high-dose fluoroscopy exams are well-known. While the incidence rate is small compared to the number of exams performed, <u>fluoroscopic injuries can be debilitating and require years of treatment.</u>

The images in Figure 1 show an example of a fluoroscopically induce skin injury. This patient underwent multiple coronary angiography and angioplasty procedures. Image 1 is a picture of the patient's back 6-8 weeks post post-procedure; Image 2 is 16 to 21 weeks post-procedure – a small ulcerated area is present; Image 3 is a close-up of the ulceration; Image 4 is a photograph of the area 18-21 months post-procedure; and, Image 5 is a photograph of the patient's back post skin grafting. (Schope 1198)

Figure 1.



https://pubs.rsna.org/doi/pdf/10.1148/radiographics.16.5.8888398

The images in Figure 2 shows another example of a fluoroscopically induce skin injury. What is unique about this case is that the injury was to the arm, which was not the primary treatment site, but which was not positioned away from the fluoroscopic beam. Image 1 shows erythema above the right elbow at 3 weeks; Image 2 shows tissue necrosis after 5 months; and, Image 3 shows the deep ulceration with exposure of the humerus at 6.5 months. (Konieg et al. 6)

tissue necrosis after 5 months; and, Image 3 shows the deep ulceration with exposure of the humerus at 6.5 months. (Konieg et al. 6)

Figure 2



Koenig et al.'s, article describes the timeframes of the various stages of radiation-induced skin responses, ranging from a few hours to one year post radiation event. For more information please visit: https://www.ajronline.org/doi/full/10.2214/ajr.177.1.1770003

Common Elements When Radiation-induced Injuries Occur

Jones, et al. describe 5 common elements that most procedures that result in preventable radiation skin injuries have in common. They are:

1. The patient was not informed that radiation skin injury was a potential risk from the procedure;
2. No efforts were made to manage radiation during the procedure;
3. The physician was not aware of how much radiation had been used when the case concluded;
4. The physician was not aware that skin injury was a potential complication of lengthy fluoroscopically-guided interventions (FGI); and,
5. The injury was not initially recognized as a radiation skin injury.

Creating a Safety Awareness Culture

Jones, et al. also suggest that development of a comprehensive safety program covering the pre-procedure, intra-procedure, and post-procedure activities governing the use of fluoroscopy is the most important step facilities can take to prevent FGI injuries. These activities include, but are not limited to:

- Training of individuals using fluoroscopy;
- Education of patients;

- Identification of patients at increased risk for skin injury (e.g., those with certain medical conditions and or taking medications that may make them more susceptible to radiation-induced skin reactions);
- Appropriate equipment maintenance and testing;
- Approaches for imaging pediatric and pregnant patients;
- Establishment and use of intra-procedure notification/alert levels;
- Establishment and use of a Substantial Radiation Dose Level (SRDL); and,
- Management of suspected tissue reactions and patient follow-up.

For a more detailed description of the steps visit the following website:
https://www.psqh.com/news/improving-safety-and-reducing-harm-from-fluoroscopy/#

The American College of Radiology® Image Wisely® campaign contains several fluoroscopy-related articles on its website page. These include:

- Checklists
- Procedure and patient's specific factors affecting radiation exposure
- Technical principles for diagnostic fluoroscopic procedures
- Technical principles for interventional procedures
- Technical principles for cardiac procedures
- Fluoroscopy protocols
- Image quality vs. utility
- Tissue attenuation of x-ray's
- Factors influencing radiation metrics during fluoroscopic procedures
- Event reporting
- Capture and analysis of radiation metrics from fluoroscopic procedures
- Managing high dose fluoroscopically guided interventional procedures
- Fluoroscopy safety awareness: High-dose operator management
- Using control charts to monitor radiation metrics
- Fluoroscopy training, credentialing and privileging
- Team performance
- Modern fluoroscopy imaging systems
- Use of ultrasound as an alternative to fluoroscopy

Cick here to review and/or share them within your facility.

Substantial Radiation Dose Levels (SRDL)

SRDLs are important concepts to understand. In addition to requiring equipment testing and staff training, The Joint Commission is also requiring facilities to identify radiation exposure and skin dose threshold levels, that if exceeded, trigger further review and/or patient evaluation to assess for adverse radiation effects. In essence, a local SRDL. For now, TJC is leaving it up to each facility to determine the actual threshold put into place up to each facility. See TJC's prepublication requirements at the end of this lesson.

Image Gently

Image Gently is the educational and awareness campaign created by the Image Gently Alliance, formed in July 2007. It is a coalition of health care organizations dedicated to providing safe, high quality pediatric imaging nationwide. The Society for Pediatric Radiology, American Society of Radiologic Technologists, American Association of Physicists in Medicine, American College of Radiology, and over 100 other North American and international medical societies are members of this coalition, representing more than 1,000,000 health care

professionals in radiology, general and subspecialty pediatrics, medical physics, and radiation safety around the world.
Click here for more information on Image Gently.

Image Wisely

The American College of Radiology and the Radiological Society of North America formed the Joint Task Force on Adult Radiation Protection to address concerns about the surge of public exposure to ionizing radiation from medical imaging. The Joint Task Force collaborated with the American Association of Physicists in Medicine and the American Society of Radiologic Technologists to create the Image Wisely campaign with the objective of lowering the amount of radiation used in medically necessary imaging studies and eliminating unnecessary procedures. Image Wisely offers resources and information to radiologists, medical physicists, other imaging practitioners, and patients.
Click here for more information on ImageWisely.

Pediatric Imaging

Image Gently Allliance

Pediatric patients represent one of the most radio-sensitive populations we serve. It is critical safe fluoroscopic procedures are followed and doses are kept to a minimum. One of the best sources of pediatric related dose reduction information is provided by the Image Gently Alliance.
The Image Gently Alliance was founded by the Society of Pediatric Radiology, American Association of Physicists in Medicine, American College of Radiology, and the American Society of Radiologic Technologists. Today the coalition has over 100 member associations world-wide.
The Alliance's primary objective is to raise awareness of the need to adjust radiation dose when imaging children.
Click here for more information on the Image Gently Alliance.

Image Gently Fluoroscopy Guidelines

This is a FREE and downloadable educational tool to provide radiologic technologists with a full understanding of the safe operation of fluoroscopic devices on pediatric patients to reduce radiation exposure and the knowledge to act as leaders in radiation protection for children. These instructional materials provide practice-based information and instructions that go well beyond that provided in the typical textbook, current literature or manufacturer training materials. In addition, the modules provide educational resources/references that may be used by secondary audiences such as radiology trainees, radiologists and medical imaging physicists. Click here to read more.

PAUSE AND PULSE - Contrast Enemas in Children - Tips for ALARA

The following document is copied directly from the Image Gently website. While it addresses Contrast Enemas in Children specifically, much of what is written is applicable in other uses of fluoroscopy. Please review and adopt, where appropriate, as many of its suggestions as possible.

PREPARATION PRIOR TO EXAMINATION:

- Clinical indication, appropriateness of study, questions to be answered, unusual anatomy or prior surgery, and type of study to be performed should be clarified as much as possible.
- Ensure that the technologist/trainee understands the planned procedure, requirements for appropriate immobilization (manual, wrapping or device), equipment and contrast needed (barium, water soluble agent or air). Close mentoring of technologist and physician trainees is essential throughout the study.

PATIENT PREPARATION:

- Explain procedure, risks and required immobilization to patient &/or parents,
    - a cooperative and helpful patient &/or parent can greatly shorten study and exposure.
- Supine overhead scout view usually obtained unless the child has a recent abdominal radiograph with decubitus or upright views as needed to evaluate for obstruction or free air.

PLACEMENT OF CATHETER: crucial for a short, efficient and successful procedure. There are many different catheter choices, including the appropriate size straight or acorn tip catheter or a Foley catheter generally with the balloon uninflated unless absolutely necessary. In infants particularly, it is helpful to make an external plug about 1-2 inches above the catheter tip by winding soft material tape around the catheter to a thickness of about 1/ 2 inch. A thin anal occluder can be placed over the tip of the catheter proximal to the plug to help provide a tight and safe external anal seal. The external plug system has the additional advantage of controlling the internal location of the catheter tip preventing undesirable high placement of the catheter or balloon. Once the catheter is placed in the rectum, it is taped in place and the buttocks firmly taped together to prevent inadvertent loss of the catheter and aid with retention of the contrast.

FLUOROSCOPIC SYSTEM: Equipment should be regularly checked and maintained. Grid controlled pulsed fluoroscopic unit with adjustable frame speeds and last image hold and capture capability highly desirable. Use the lowest pulse rate whenever possible. Remove anti scatter grid especially in smaller children. Ensure that fluoroscopic protective lead barriers on the tower unit are in place and place upper and lower lead shields under the patient as appropriate. Match tube output (kVp and mAs) to the size of the child. Make sure the timer is reset.

COLLIMATE / NO MAGNIFICATION: Bring the image intensifier tower as close as possible to the patient. Preset the collimators to the likely field of view and position the unit over the anatomic location of interest prior to beginning fluoroscopy. Adjust collimation throughout the study to include the area of interest only excluding the gonads wherever possible. Image at lowest magnification; magnify only specific images if needed.

STEP LIGHTLY: Step lightly on the fluoroscopy pedal. Hand or foot controls, intermittent visualization only as needed. Depending on clinical indication may start looking at rectum in the lateral view and then most of the remainder of the study with the child supine or obliqued as needed. Useful in children to follow the head of the contrast column saving screen images along the way. Keep fluoroscopy away from the pelvis and gonads as much as possible once the rectosigmoid has been imaged.

PAUSE fluoroscopy whenever feasible and use screen images for exam planning and problem solving during the study.

IMAGES: Most images obtained during the study can be screen saves without any additional radiation. If more detail is needed some images can be camera spots with no need for cine or cassette film images. Images obtained depend on the clinical concern but will usually include frontal (possibly also lateral) rectum, rectosigmoid junction, splenic and hepatic flexures, cecum and terminal ileum. Post-evacuation view/s can often be obtained as a fluoroscopic save or camera spot versus an overhead radiograph if needed.

FLUOROSCOPY TIME: Check fluoroscopic time used, permanent time/dose documentation as per the policy of hospital/ department

SUMMARY:

- PAUSE to properly plan and prepare for study
- Activate dose saving features of equipment
- No exposures unless necessary
- Depress last image hold and last image grab instead
- PULSE at lowest possible rate

Image Gently also makes available checklists for physicians and technologists when performing fluoroscopic procedures. Please familiarize yourself with them.

Click here to see Image Gently's Pause and Pulse Checklist for Physicians.

Click here to see Image Gently's Pause and Pulse Checklist for Technologists.

Staff Safety

Operator and staff safety is a critical component of any radiation safety program. There are several basic rules to reduce staff exposure when working with all forms radiation. Protective clothing reduces effective dose, as do appropriate use of distance, time, and use of protective clothing and devices. Important considerations of any effective staff safety program includes the following:

- **Distance;**
    - dose is inversely proportional to distance;
        - e.g., radiation dose at 2 feet away is 4x the dose at 4 feet away
    - staff should be no closer to the tube than necessary
- **Fluoroscopy time;**
    - all else being equal, exposure is linear with fluoro time;
    - reducing the amount of time x-rays are on reduces everyone's exposure;
    - Make judicious use of pulsed fluoroscopy, use the lowest settings possible to obtain a quality image, and only turn fluoroscopy beam on when necessary
- **Shielding;**
    - appropriate use of table side drapes, ceiling and mobile shields substantially reduce exposure rates;
    - Fixed and mobile shields are often appropriate and easy to use
- **Protective clothing**
    - Radiation protective garments such as lead aprons, skirts, thyroid shields, and eye shields should be used;
    - The lead aprons (or jacket skirt combination) protects key central body organs and active marrow.
    - Follow proper care instructions when not in use - the protective value can be reduced if mishandled.

The Joint Commission ® June 25, 2018 Fluoroscopy Prepublication Requirements effective January 1, 2019

Standard EC.02.04.03: For hospitals that provide fluoroscopic services: At least annually, a diagnostic medical physicist conducts a performance evaluation of fluoroscopic imaging equipment. The evaluation results, along with recommendations for correcting any problems identified, are documented. The evaluation includes an assessment of the following:

- Beam alignment and collimation
- Tube potential/kilovolt peak (kV/kVp) accuracy
- Beam filtration (half-value layer)
- High-contrast resolution
- Low-contrast detectability
- Maximum exposure rate in all imaging modes
- Displayed air-kerma rate and cumulative-air kerma accuracy (when applicable)

The hospital verifies and documents that individuals (including physicians, non-physicians, and ancillary personnel) who use fluoroscopic equipment participate in ongoing education that includes annual training on the following:

- Radiation dose optimization techniques and tools for pediatric and adult patients addressed in the Image Gently® campaign
- Safe procedures for operation of the types of fluoroscopy equipment they will use

Note 1: Information on the Image Gently initiative can be found online at http://www.imagegently.org.
Standard LD.04.01.05: The hospital designates an individual to serve as the radiation safety officer who is responsible for making certain that radiologic services are provided in accordance with law, regulation, and organizational policy. This individual has the necessary authority and leadership support to do the following:

- Monitor and verify compliance with established radiation safety practices (including
- oversight of dosimetry monitoring)
- Provide recommendations for improved radiation safety
- Intervene as needed to stop unsafe practices
- Implement corrective action

Standard PC.01.02.15: For hospitals that provide fluoroscopic services: The cumulative-air kerma or kerma area product are documented in a retrievable format. For fluoroscopy equipment that cannot display or provide cumulative-air kerma or kerma-area product, fluoroscopy time and number of images acquired are documented in a retrievable format, such as a picture archiving and communication system.
Standard PC.02.01.01: For hospitals that provide fluoroscopic services: The hospital identifies radiation exposure and skin dose threshold levels, that if exceeded, trigger further review and/or patient evaluation to assess for adverse radiation effects.
Note 1: Information on radiation exposure thresholds can be found in the National Council on Radiation Protection (NCRP)'s report number 168 and on the Food and Drug Administration's (FDA) Center for Devices for Radiological Health (CDRH) website.
Note 2: Radiation exposure thresholds may be established based on metrics such as reference-air kerma, cumulative-air kerma, kerma-area product, or fluoroscopy time.
(See also PI.02.01.01, EP 20)
Standard PI.02.01.01: For hospitals that provide fluoroscopic services: The hospital reviews and analyzes instances where the radiation exposure and skin dose threshold levels identified by the organization are exceeded.
Note: Radiation exposure thresholds may be established based on metrics such as reference-air kerma, cumulative-air kerma, kerma-area product, or fluoroscopy time.

References

Schope Thomas B., PhD. "Radiation-induced Skin Injuries from Fluoroscopy." *Imaging and Therapeutic Technology, Radiographics*, 1996; 16, pp.1195-1199
Koenig, Titus R., Wolff, Mettler, and Wagner. "Skin Injuries from Fluoroscopically Guided Procedures: Part 1, Characteristics of Radiation Injury." *AJR*, 177, July 2001, pp. 3-11
Jones, Kyle., Pasciak. "Improving Safety and Reducing Harm from Fluoroscopy." *Public Safety & Quality Healthcare*, 27 May 2015, //www.psqh.com/news/improving-safety-and-reducing-harm-from-fluoroscopy/# Accessed 9 Dec. 2018

Name ________________________________ ; Date__________________

Using the DIR to Implement an Effective CT Dose Monitoring Program and Meet TJCs Dose Incident Identification Requirements Quiz

1. This course teaches Fluoroscopy users all they need to know about fluoroscopy safety and dose optimization.
    a. True
    b. False
2. In 2006 the NRCP reported that Interventional Fluoroscopy was the third largest source of medical radiation exposure in the US behind _________________ ?
    a. Computerized Tomography and Nuclear Medicine
    b. General X-ray and Bone Density
    c. Dental and PET
3. Severe skin injuries as a result of high-dose fluoroscopy exams, while infrequent, can be debilitating and require years of treatment.
    a. True
    b. False
4. Jones, et al. describe 5 common elements present when preventable radiation skin injuries occur. Which of the following reasons were not among them:
    a. Skin injuries are more likely to occur during the first exam of the day.
    b. No efforts were made to manage radiation during the procedure.
    c. The physician was not aware of how much radiation had been used when the case concluded.
    d. The physician was not aware that skin injury was a potential complication of lengthy fluoroscopically-guided interventions (FGI).
5. QUESTION: Jones, et al., concluded that having a comprehensive fluoroscopy safety program helped prevent fluoroscopically-related radiation induced injuries.
    a. True
    b. False
6. QUESTION: Image Gently® and Image Wisely® are campaigns to reduce the amount of radiation used in medically necessary imaging and eliminate unnecessary procedures.
    a. True
    b. False
7. QUESTION: Which of the following are important consideration for reducing operator and staff exposure
    a. Distance from radiation source to operator or staff
    b. Fluoroscopy time use during the procedure
    c. Shielding
    d. Protective clothing
    e. All of the above
8. Pediatric exams should take the patient's age and size into account during the pre-study planning phase.
    a. True
    b. False
9. QUESTION: Any fluoroscopy study whose reference-air kerma dose (or fluoro minutes used if not reference-air-kerma capable) that exceeds the facility's substantial radiation dose limits should be reviewed and analyzed.
    a. True
    b. False

Answer Key

1. False
2. a. Computerized Tomography and Nuclear Medicine
3. True
4. a. Skin injuries are more likely to occur during the first exam of the day.
5. True
6. True
7. e. All the above
8. True
9. True

CERTIFICATE OF COMPLETION

Fluoroscopic Dose Optimization: Tools and Techniques for Pediatric and Adult Patients

This Certificate is presented to:

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For Successfully Completing:

Fluoroscopic Dose Optimization: Tools and Techniques for Pediatric and Adult Patients

Awarded on: _____________

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Signed BY